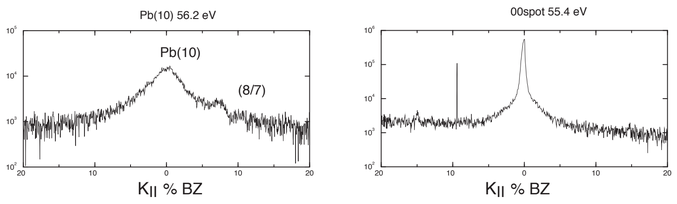
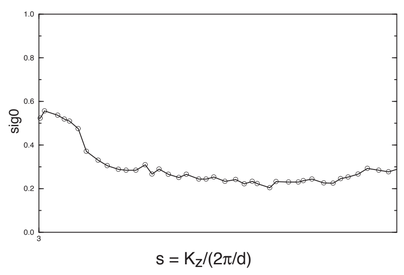
How stable are the islands with thermal annealing?

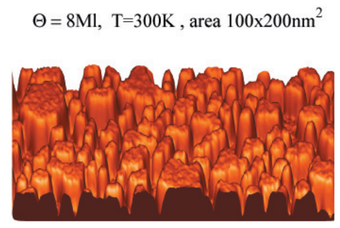


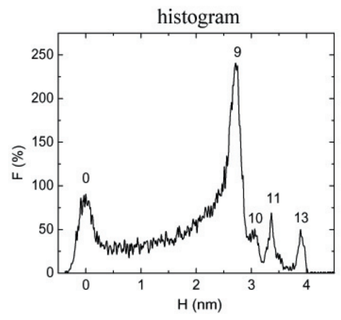
T=250K



No oscillations are observed in the g(s) curve □ because the islands become larger in size and height.

By growing at higher temperatures the island height increases by 2d and the islands grow laterally. The island height distribution broadens. At room temperature the large Pb islands are separated by regions of the wetting layer.





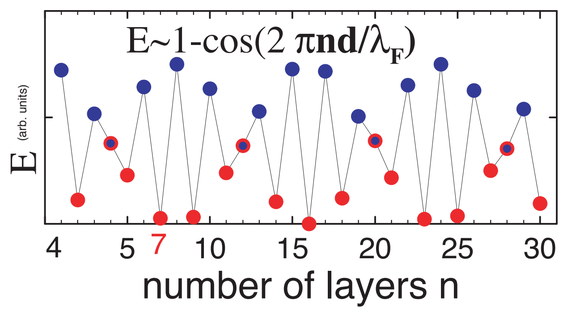
The island height increases □ by bilayer increments.

What is the origin of this unusual growth mode?

Island height 7d is first multiple of Fermi wavelength.
Growth with 2d steps is explained by QSE, too.

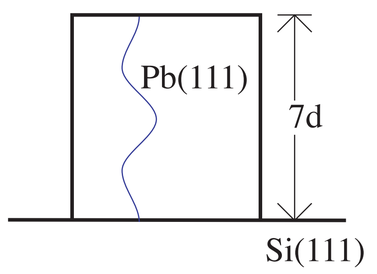
n	4	5	6	7	8	9	10
2nd/λ_F	6.25	7.81	9.38	10.94	12.50	14.07	15.62

d=2.86A λ_F =3.66A [A.Crottini et.al. PRL 79,8(1997)]



Minima are observed at 5, 7, 9,...layers

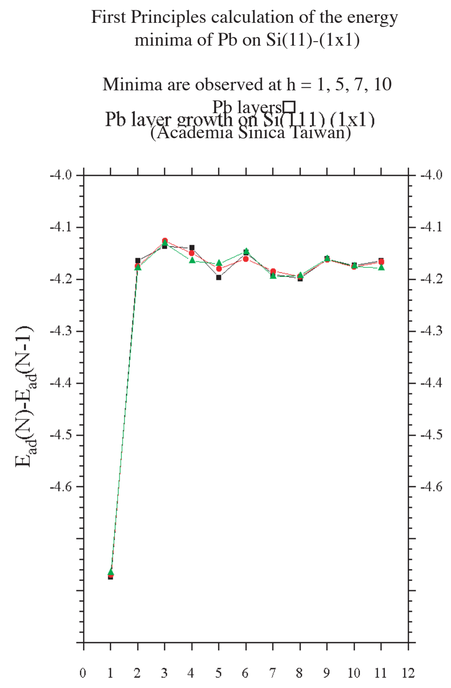
QSE: Quantum Size Effects



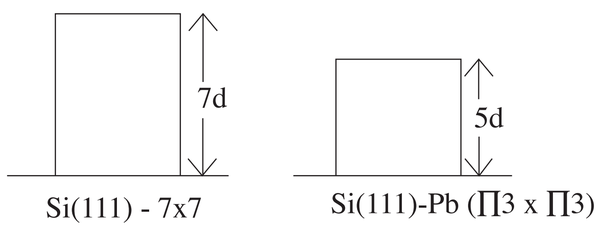
The electrons confined in the islands have "bulk" Fermi-wavelength λ_F. At what thickness the electron wavefunction forms stading waves? □

□

2nd / λ_F = integer



What is the role of the metal/semiconductor interface?

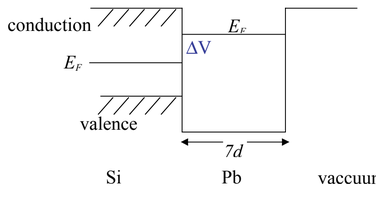


$\varepsilon = \varepsilon_{confine} + \varepsilon_{charge\ transfer}$

Charge is transferred at the metal/semiconductor interface

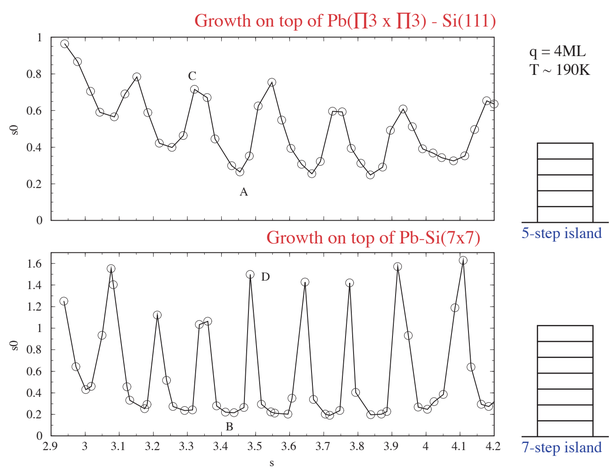
$$\varepsilon_{cha} = \frac{1}{2} q\Delta V^2$$

(ΔV = difference between the Fermi level in the semiconductor and the metal.) Zhang et. al PRL 80 5381 (1998).



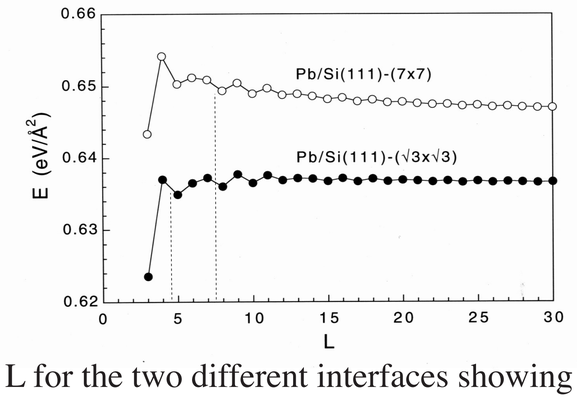
ΔV = 0.50 eV (on Pb/Si—(7x7))
ΔV = 0.73 eV (on Pb/Si—Pb($\sqrt{3}\times\sqrt{3}$))

Larger contribution on $\sqrt{3}\times\sqrt{3}$ than 7x7.
Photoemission Weitering et al PRB 45 9126 (1992).



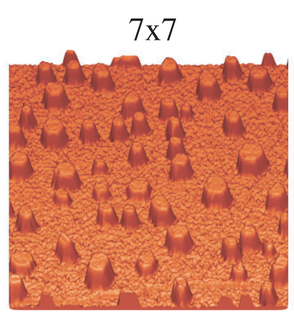
V. Yeh et. al; PRL 85 5158(2000)

Mostly 5-step islands are observed on the $\sqrt{3}\times\sqrt{3}$ and mostly 7-step islands are observed on the (7x7).



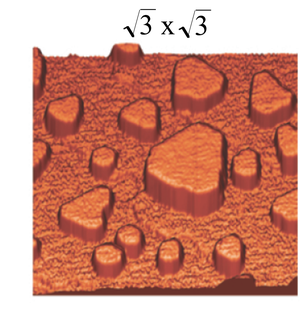
E vs L for the two different interfaces showing that L=5 is a lower minimum on the $\sqrt{3}\times\sqrt{3}$ than □ L=7 on the (7x7) phase.

200x200nm



θ=3.3ML

T=192K



θ=3.3ML

Conclusions□

I. Uniform height islands can be grown on Pb/Si(111) at low temperatures.

II. The (T,θ) phase diagram can be used as a guide to select the island height.

III. The island height can be also controlled by selecting the interface.

IV. This unusual growth morphology confirms the role of QSE and charge transfer at the metal/semiconductor interface.